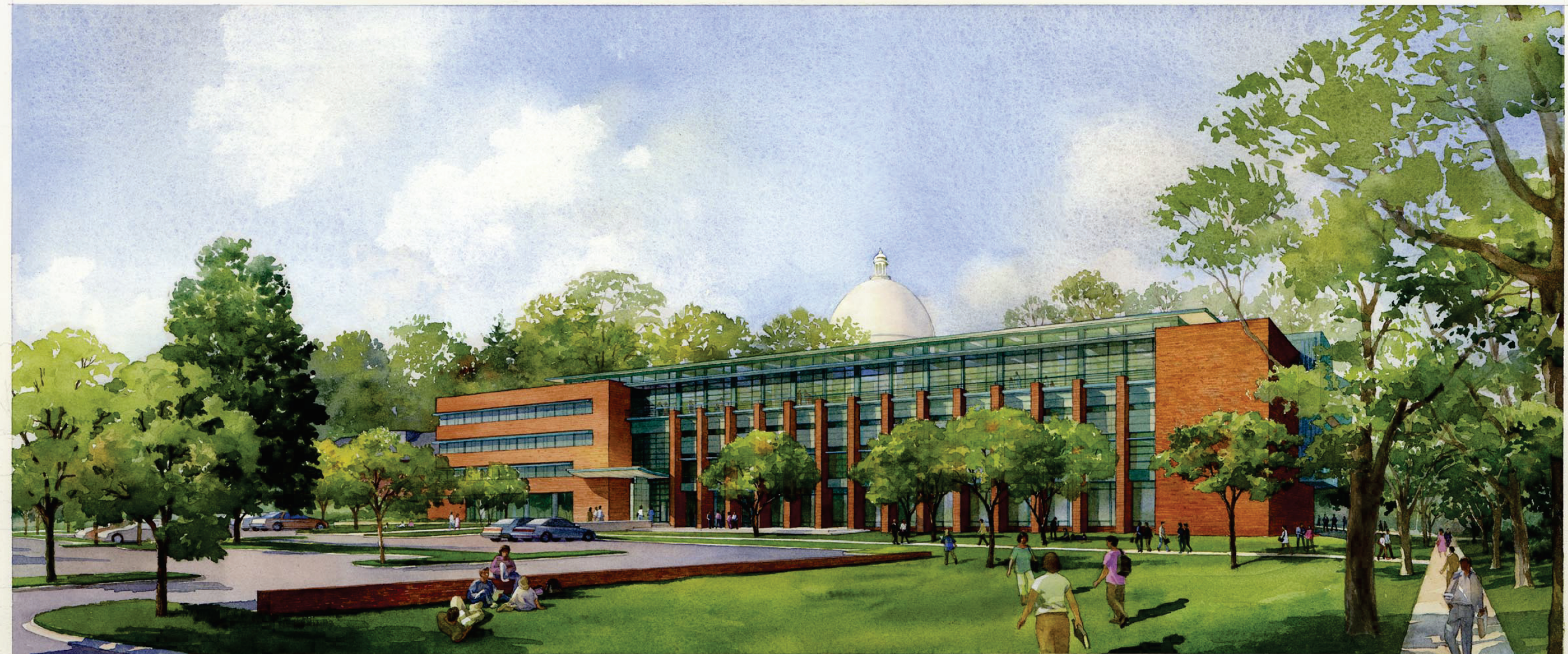


Penn State SALA Daylighting Report

Prepared for Overland Partners

Final Revision
July 26, 2002



Introduction

This daylighting report consists of discussion on two topics. First, findings on daylight factors are discussed. The daylight factor discussion focuses on meeting the requirements of L.E.E.D. Credit 8 under Indoor Environmental Quality in the Sustainable Narrative (10.24.01) which reads:

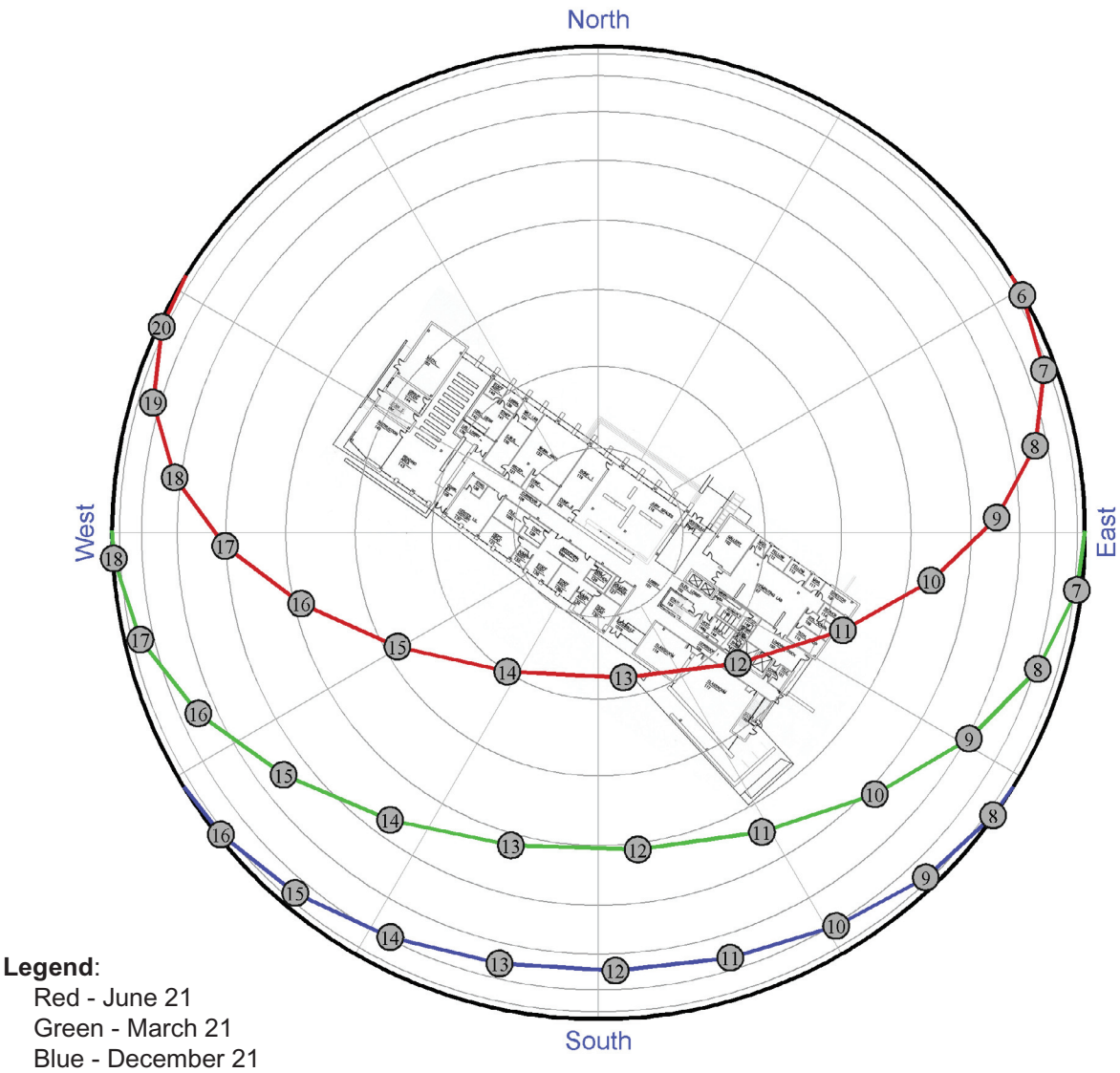
A connection between indoor spaces and the outdoor environment will be provided by the introduction of sunlight and views into the occupied areas of the building. Except for spaces where daylight would hinder a task, a minimum daylight factor of 2% will be achieved in 75% of all spaces occupied for critical visual tasks.

The second discussion in this report concerns geometries of architectural shading elements including overhangs, lightshelves, and fins. The geometries of various shading elements will be investigated to determine how much shading is provided, and when the element fails to provide shade.

Solar Environment

The sunpath diagram to the left illustrates the path of the sun through the days June 21 (red), March 21 (green), and December 21 (blue). Note that the orientation of the building is 35° off of the compass directions. The south facade actually faces south-southwest. Throughout this report it will be referred to as the south facade but it is important to remember that it isn't actually a south facing facade. The same is true for the other facades as well.

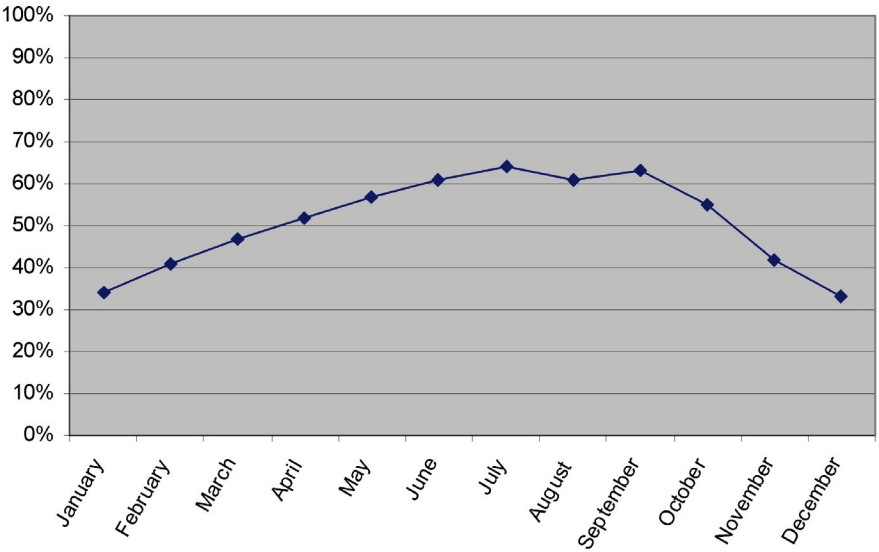
The graph at the bottom of the page shows the probability of sunshine throughout the year. State College has very little sunshine in the winter months. In December (the lowest month) the sun shines only 33% of the time. Thus, in December two of every three days are overcast. The sun shines more often in the summer, peaking in July at 64%.



Legend:
Red - June 21
Green - March 21
Blue - December 21

Probability of Sunshine

Based on Pittsburgh, PA



Daylight Factors

A daylight factor is the ratio of exterior horizontal illuminance to interior horizontal illuminance under uniform or cloudy sky conditions. Daylight factor grids were calculated for each normally occupied space in the SALA building. A CIE uniform sky condition was used for this analysis.

In this analysis daylight factors were calculated for each point on a grid with a one foot by one foot resolution. No obstructing furniture was included in the calculations. The analysis was carried out using the 3D model provided by Overland and Partners with some modifications to reflect recent changes conveyed in drawings.

The following types of spaces are excluded from this analysis:

- Spaces which are not normally occupied (i.e. mech/elec rooms, & storage/ archive spaces).
- Spaces which are not occupied for a critical task (i.e. bathrooms, corridors, lobbies, stairways & social spaces)
- Spaces in which daylight could be damaging (i.e. gallery)
- Spaces in which daylight would hinder a task (i.e. computer lab, av classrooms, crit areas & multimedia).

The table to the left is a summary of the daylight factors the entire building. The first column is the percent of floor area of spaces on each floor with a daylight factor of 2% or greater. The second column is the approximate total floor area of spaces for each floor. And the third column is the floor area of spaces with a daylight factor of 2% or more.

Overall, 80.1% of the analyzed space in the building has a daylight factor of 2% or greater. This number exceeds the 75% required by L.E.E.D., and therefore no improvements are necessary. Floor by floor breakdowns detailing each space follow.

	Part of floor in which D.F.> 2%	Approx Area (sqf)	Area > 2% DF
Total for first floor:	69.0%	12156	8384.843
Total for second floor:	77.5%	20978	16249.13
Total for third floor:	66.8%	2871	1918.77
Total for fourth floor:	94.4%	15876	14980.16
Total for entire building:	80.1%	51881	41532.9

Space	Room Number	Part of room in which D.F.> 2%	Approx Area (sqf)	Area > 2% DF	Notes
Director	108	72.2%	217	156.7	Calculated estimate based on revised plan.
System Adminstrator	109	60.0%	264	158.4	
Manager	110	100.0%	95	95.0	
Manager	111	100.0%	95	95.0	
Fellow	112	100.0%	139	139.0	
Fellow	113	100.0%	139	139.0	
Jury Spaces	118	74.3%	2077	1543.8	
Conference 1 & 2	119 & 120	52.8%	786	415.1	
Reception	121	0.0%	185	0.0	
Conference	122	0.0%	256	0.0	
Work Area	123	94.9%	1112	1054.8	
Reception	126	0.0%	393	0.0	
Dept Head	130	59.6%	315	187.8	
Dept Head	131	100.0%	368	368.0	
Admin Asst.	132	18.1%	119	21.5	
Admin Asst.	133	100.0%	105	105.0	
Staff Asst.	135	100.0%	289	289.0	
Staff Asst.	135A	99.6%	267	266.0	
Center LS. History	137	98.1%	586	574.6	
Library Lobby	138	0.0%	215	0.0	
Librarian	139	100.0%	118	118.0	
Staff Asst.	140	100.0%	112	112.0	
Staff	141	0.0%	155	0.0	
Circ. Desk	142	0.0%	302	0.0	
Reading Area	143	66.5%	2521	1677.3	
Group Study	144	80.0%	273	218.4	Calculated estimate
Instruction	145	99.6%	653	650.4	
Total for first fl.		69.0%	12156	8384.8	

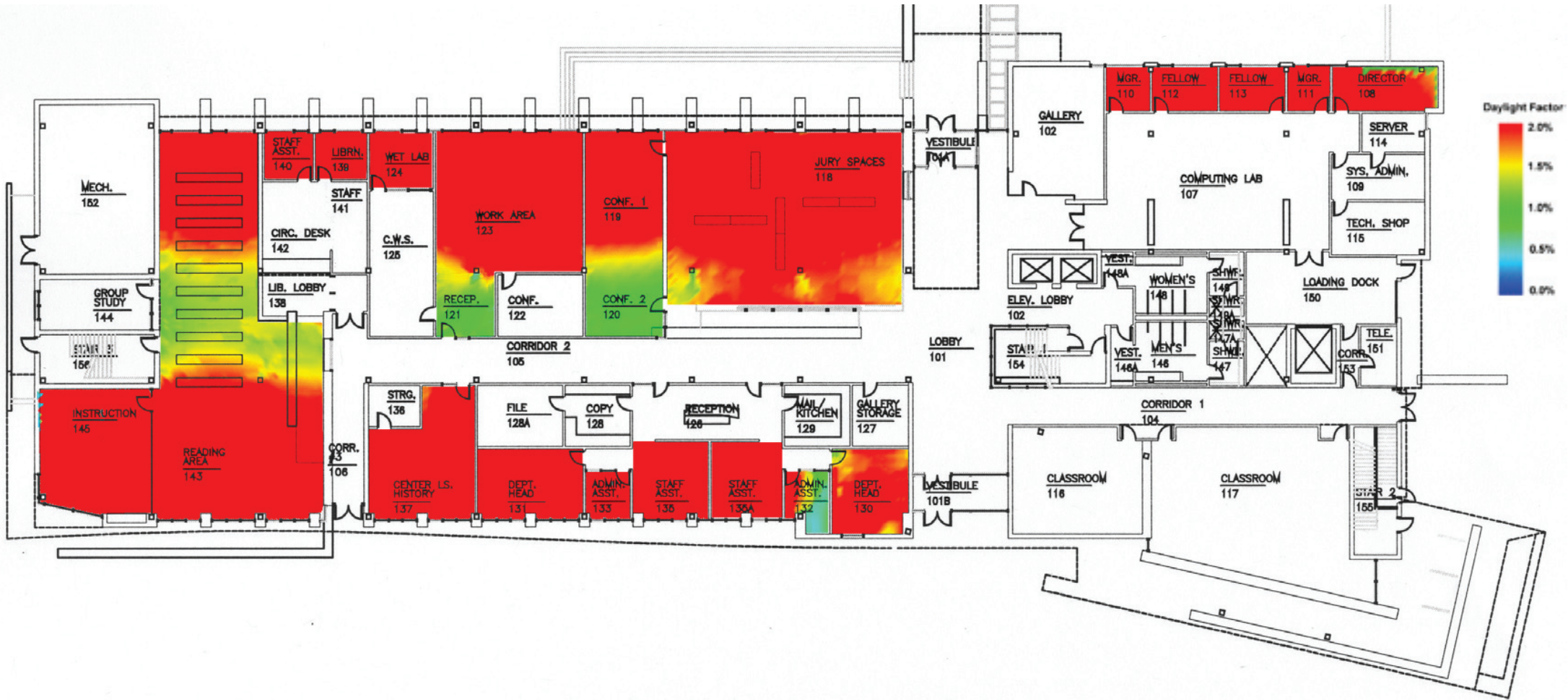
Daylight Factors - Ground Floor

The plan in the lower portion of this page shows daylight factor grids for the daylight spaces. Red indicates that the daylight factor is greater than or equal to 2% for that area. Dark blue indicates a daylight factor of 0%.

The table to the left shows the percentage of each normally occupied space that has a daylight factor greater than 2%. The "Area >2% DF" column in the table is the area of the room which has a daylight factor of greater than 2%.

The daylight factor values for the group study room just off the library is an estimate at this time. Also, the layout of the system administrator's office (rm. 109) and the server closet (rm. 114) has been changed (not reflected in plan on this page). The daylight factor for this space is an estimated calculation as well.

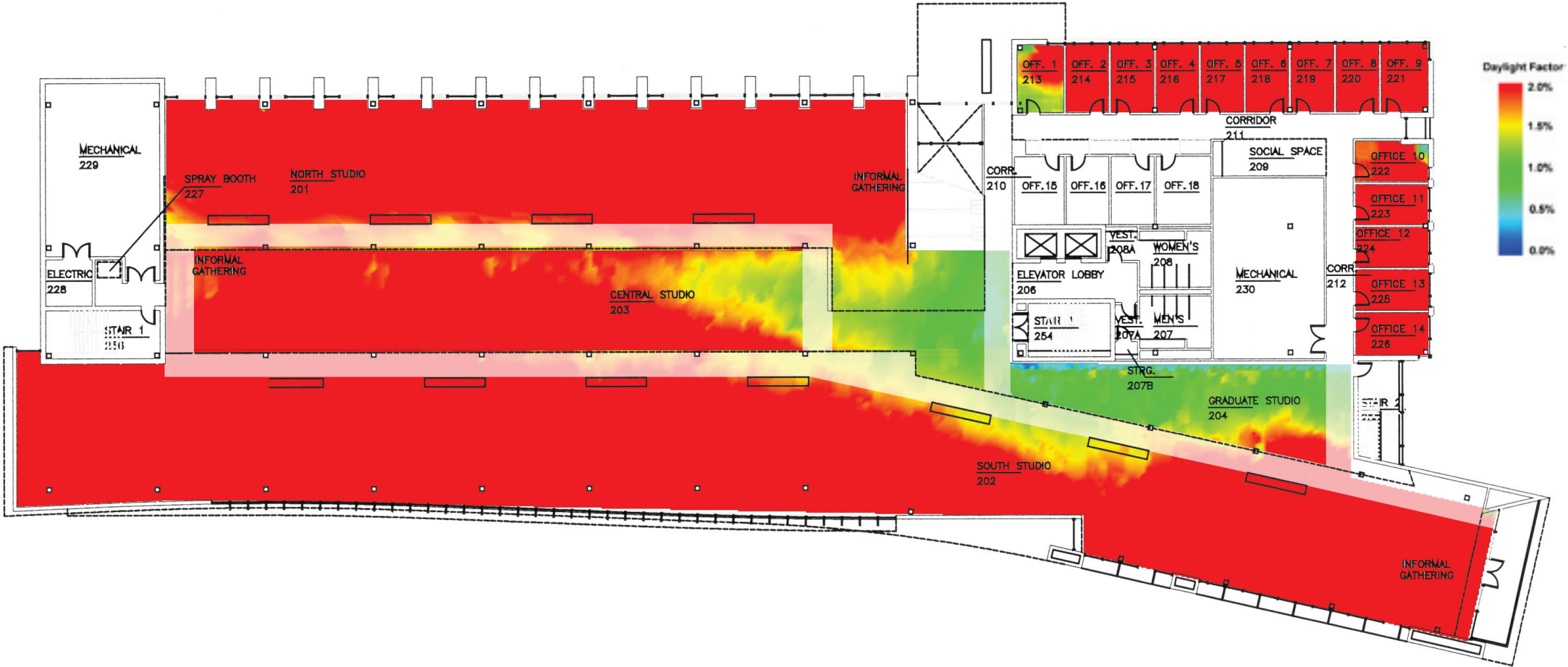
On the first floor, 69% of the space included in the analysis has a daylight factor of 2% or more.



Space	Room Number	Part of room in which D.F.> 2%	Approx Area (sqf)	Area > 2% DF	Notes
North Studio	201	94.2%	4296	4045.0	Excluding circulation zones
South Studio	202	90.9%	8885	8078.4	Excluding circulation zones
Central Studio	203	54.4%	4002	2178.6	Excluding circulation zones
Graduate Studio	204	4.2%	1102	46.6	Excluding circulation zones
Office 1	213	35.6%	158	56.2	
Office 2	214	100.0%	144	144.0	
Office 3	215	100.0%	144	144.0	
Office 4	216	100.0%	144	144.0	
Office 5	217	100.0%	144	144.0	
Office 6	218	100.0%	144	144.0	
Office 7	219	100.0%	144	144.0	
Office 8	220	100.0%	144	144.0	
Office 9	221	100.0%	159	159.0	
Office 10	222	64.8%	144	93.4	
Office 11	223	100.0%	144	144.0	
Office 12	224	100.0%	144	144.0	
Office 13	225	100.0%	144	144.0	
Office 14	226	100.0%	152	152.0	
Office 15		0.0%	168	0.0	
Office 16		0.0%	144	0.0	
Office 17		0.0%	144	0.0	
Office 18		0.0%	184	0.0	
Total for second floor:		77.5%	20978.0	16249.1	

Daylight Factors - Second Floor

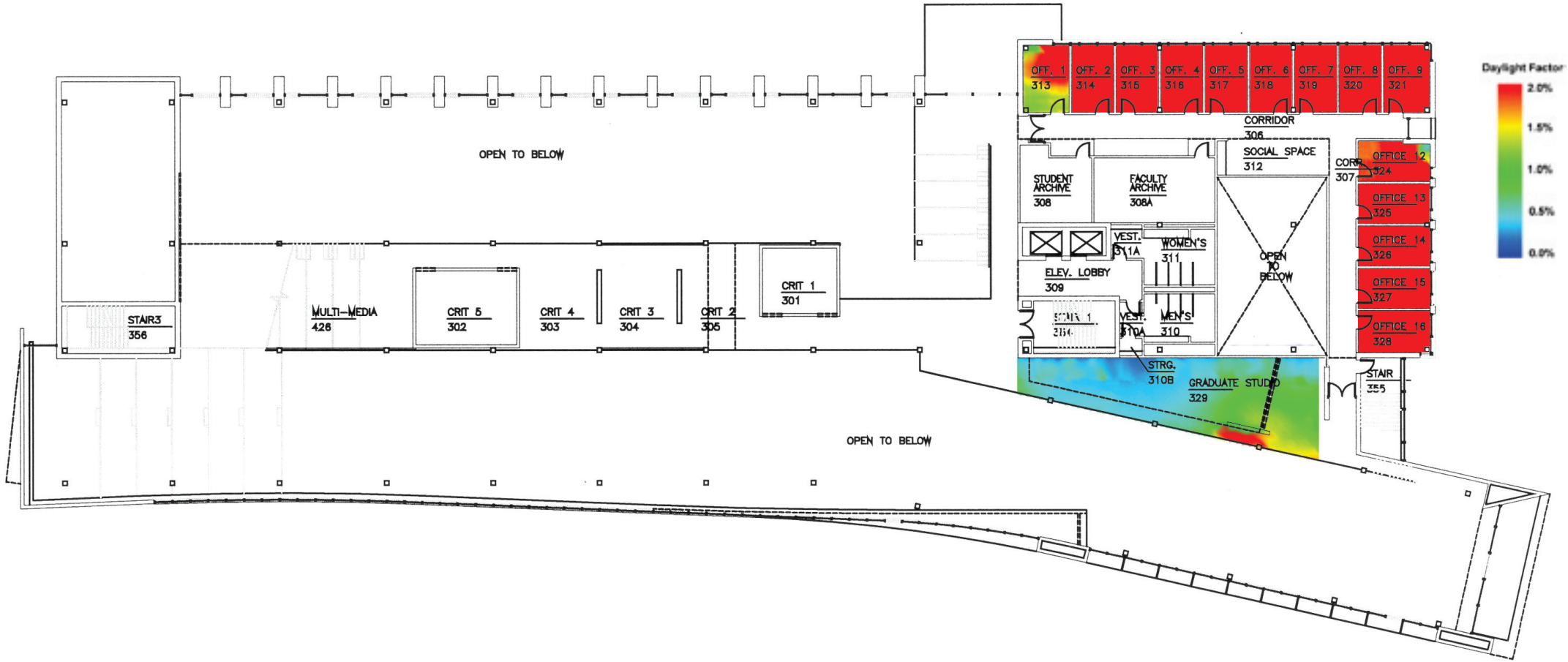
On the second floor, 78% of the space included in the analysis has a daylight factor of 2% or more. Circulation zones (white-washed areas) have been excluded from the analysis, because it is not an area that is occupied for critical tasks.



Space	Room Number	Part of room in which D.F.> 2%	Approx Area (sqf)	Area > 2% DF	Notes
Office 1	313	35.6%	158	56.2	
Office 2	314	100.0%	144	144.0	
Office 3	315	100.0%	144	144.0	
Office 4	316	100.0%	144	144.0	
Office 5	317	100.0%	144	144.0	
Office 6	318	100.0%	144	144.0	
Office 7	319	100.0%	144	144.0	
Office 8	320	100.0%	144	144.0	
Office 9	321	100.0%	159	159.0	
Office 12	324	64.8%	144	93.4	
Office 13	325	100.0%	144	144.0	
Office 14	326	100.0%	144	144.0	
Office 15	327	100.0%	144	144.0	
Office 16	328	100.0%	152	152.0	
Graduate Studio	329	2.2%	818	18.2	
Total for third floor:		66.8%	2871	1918.8	

Daylight Factors - Third Floor

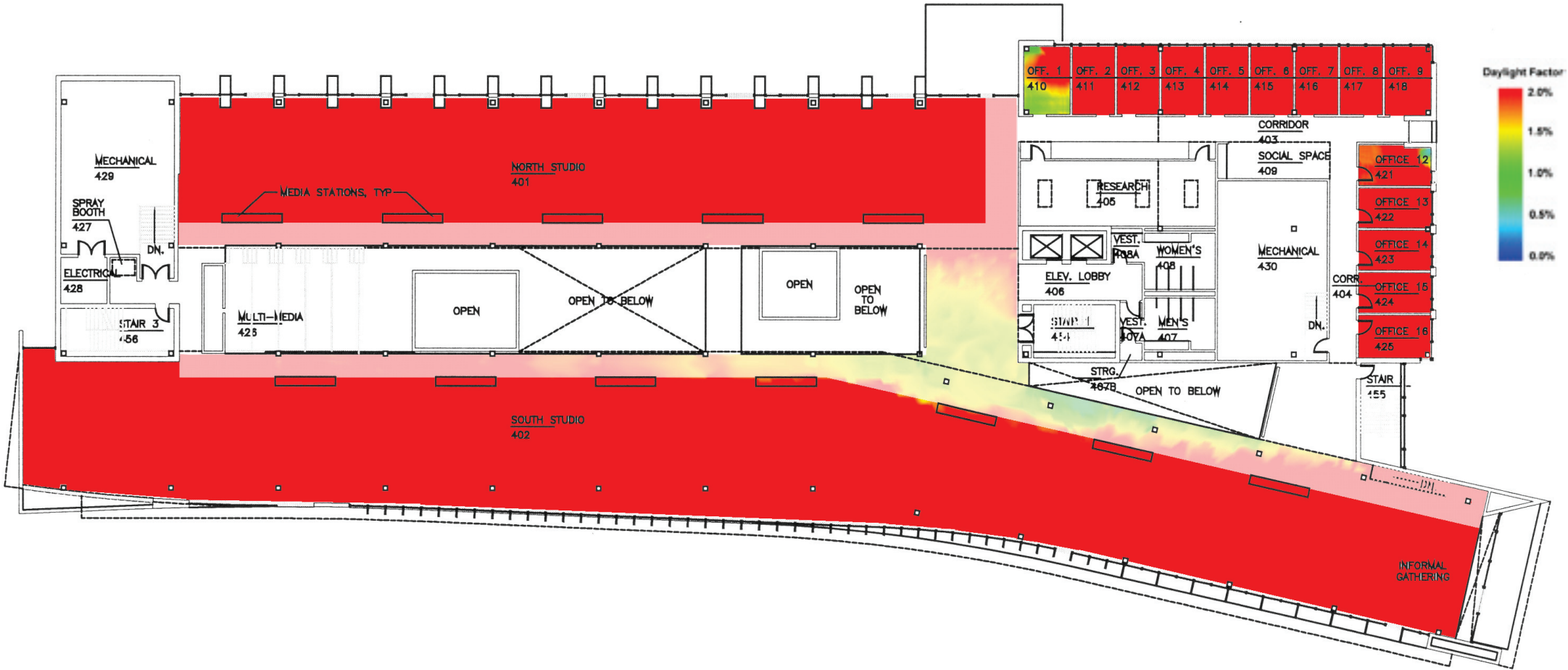
On the third floor, 67% of the space included in the analysis has a daylight factor of 2% or more. Again, circulation zones (white washed areas) and spaces where daylight would hinder task were excluded from daylight factor analysis.



Space	Room Number	Part of room in which D.F.> 2%	Approx Area (sqf)	Area > 2% DF	Notes
North Studio	401	100.0%	4296	4296.0	Excluding circulation zones
South Studio	402	98.9%	8885	8783.6	Excluding circulation zones
Research	405	0.0%	642	0.0	
Office 1	410	35.6%	158	56.2	
Office 2	411	100.0%	144	144.0	
Office 3	412	100.0%	144	144.0	
Office 4	413	100.0%	144	144.0	
Office 5	414	100.0%	144	144.0	
Office 6	415	100.0%	144	144.0	
Office 7	416	100.0%	144	144.0	
Office 8	417	100.0%	144	144.0	
Office 9	418	100.0%	159	159.0	
Office 12	421	64.8%	144	93.4	
Office 13	422	100.0%	144	144.0	
Office 14	423	100.0%	144	144.0	
Office 15	424	100.0%	144	144.0	
Office 16	425	100.0%	152	152.0	
Total for fourth floor:		94.4%	15876	14980.16	

Daylight Factors - Fourth Floor

On the fourth floor, 94% of the space included in the analysis has a daylight factor of 2% or more. Once again, circulation zones (white-washed areas) were excluded.



Office Shading - Overhangs

Sun-shading overhangs are used to provide shading for windows in order to reduce direct glare. Profile angles are used to best evaluate the effects an overhang. A profile angle is the angle the sun makes with a surface when projected to a plane which is perpendicular to the surface and to the ground. The profile angle of the sun at any specific time can be compared to the angle of shading provided by the overhang to see if the sun is shaded at that time.

NOTE: Solar altitude and profile angle are not the equivalent. It is possible to have a high profile angle when the sun is low in the sky. However, when considering the effects of trees and buildings near the site the solar altitude is the appropriate angle to use. For example: at 8 pm on June 21, the profile angle for the sun on the south facade is about 35° which means that it will shine into the south studio, however the solar altitude is only 7° thus the sun will most likely be blocked by trees at that time.

There are overhangs above the windows of the offices in the northeast corner of the building. Nine offices on each floor have north facing windows, and five with east facing offices.

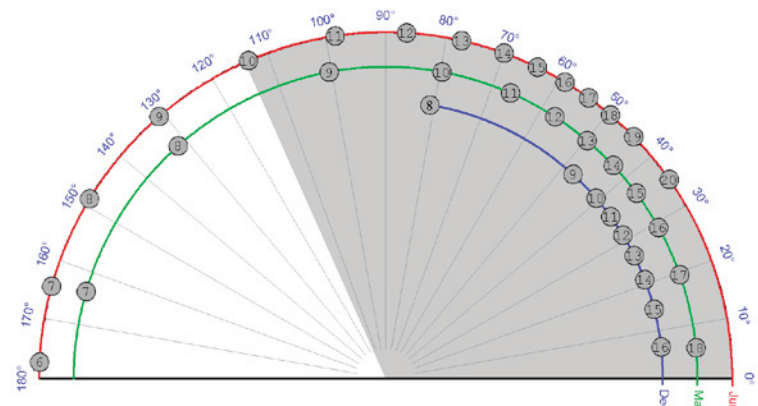
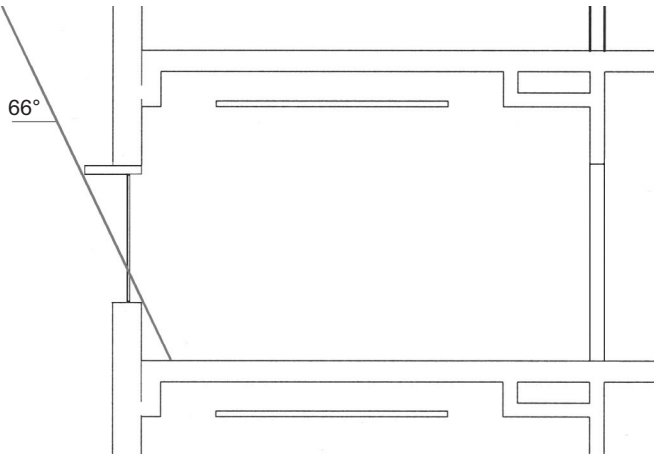
The diagrams on the right illustrate the path of the projected onto a dome, in plan view (as if you are looking down at the site). Again, the part of the diagram that is shaded gray corresponds to the angles in which the overhang will completely shade the window from direct sun.

The diagrams in the center plot the profile angle of the sun for each hour of a day on the outer edge of the semi-circle. The part of the diagram that is shaded gray corresponds to the angles in which the overhang will completely shade the window from direct sun.

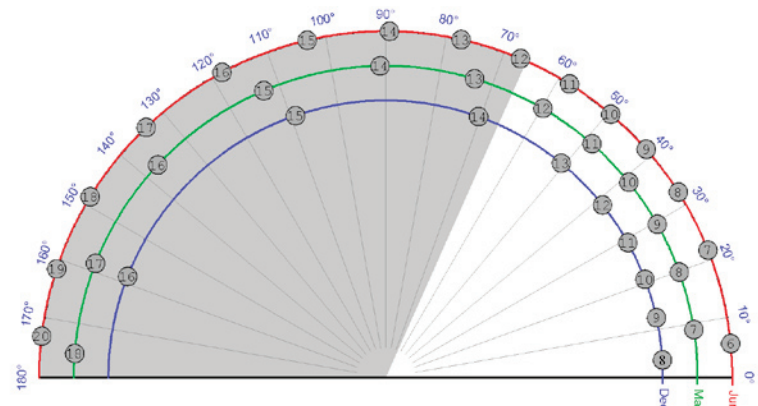
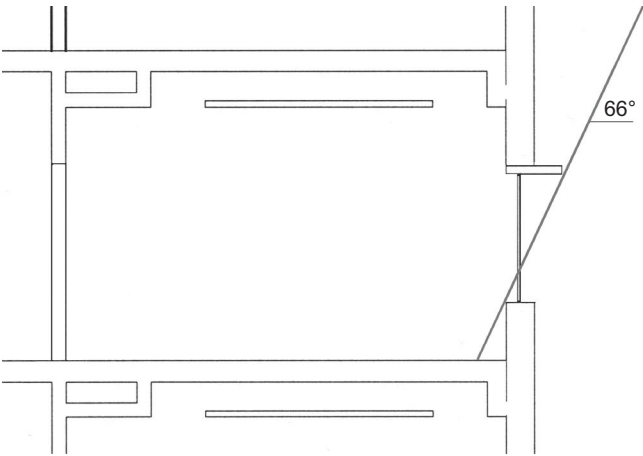
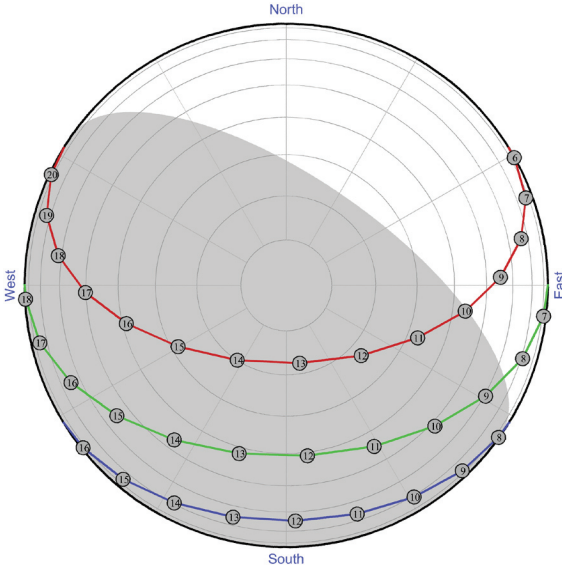
Section views to the extreme left illustrate the shading angles of each overhang.

The east offices will see sun during the morning throughout the entire year. Morning sun will cause a major problem in the east offices. The images at the bottom show the office at two times when there will be a lot of sun in the office. It is recommended that an operable shading device be provided to allow occupants of the east offices to reduce glare effects from the direct sun. A shading device that doesn't completely block light would be preferred. A diffusely transmitting scrim shade would be ideal. This way the occupant can still benefit from natural lighting in the space without the hindrance of direct sunlight.

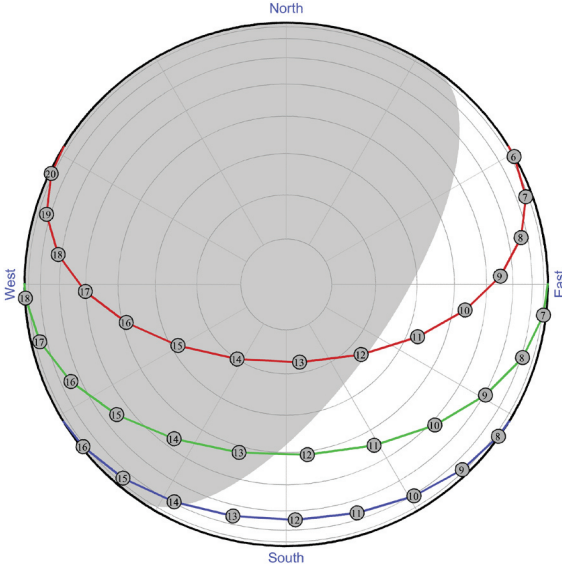
The windows of the north offices only see sun early in the morning during the summer months. By 8:00 am the azimuthal angle of the sun is such that the sun will mostly shine onto the west wall. Shades are recommended for the north facing offices as well, but aren't crucial as far as glare issues are concerned.



North Offices - Window Overhang
The overhang above the windows of the north offices (office 1-9 on the second, third and fourth floors) allows sun penetration in the early morning all during the summer months.



East Offices - Window Overhang
The overhang above the windows of the east offices (office 10-14 on the second floor and office 12-16 on the third and fourth floors) allows sun penetration in the morning all year long.



East Office - December 21, 10: 00 am



East Office - March 21, 8: 00 am

Solar Shading - North Studios

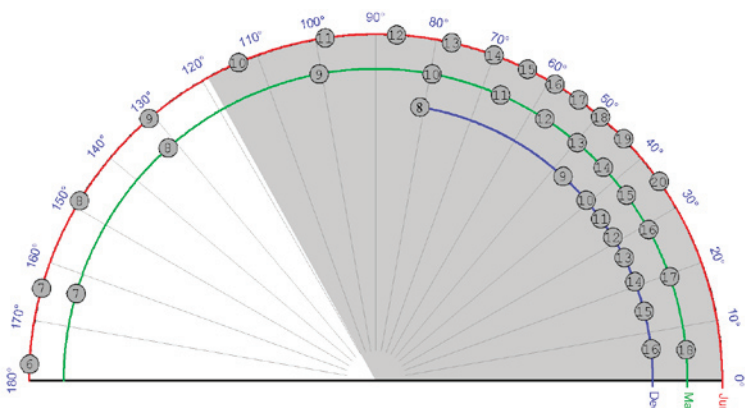
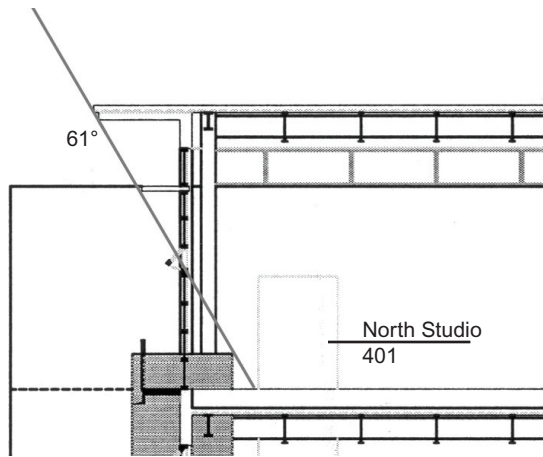
The overhang for the north windows of the 4th floor north studio is adequate, sun penetration will occur in the mornings during the summer, but will only until 9 am.

The overhang for the south windows of the 4th floor north studio is also adequate. Penetration will occur during the afternoon in the winter, however the window opening is small, thus amount of sun would also be small. If any additional shading is desired, window frit, or another partial diffusing material should be used.

The 2nd floor north studio have oversized columns that will provide shading. When evaluating vertical shading elements, The azimuthal angle of the sun is most important. The azimuth angle describes the direction of the sun (south, east, north etc.). The diagrams on the right (marked plan) show the path of the sun through a day projected onto a dome. The gray area represents the areas where the sun is shaded by the vertical elements.

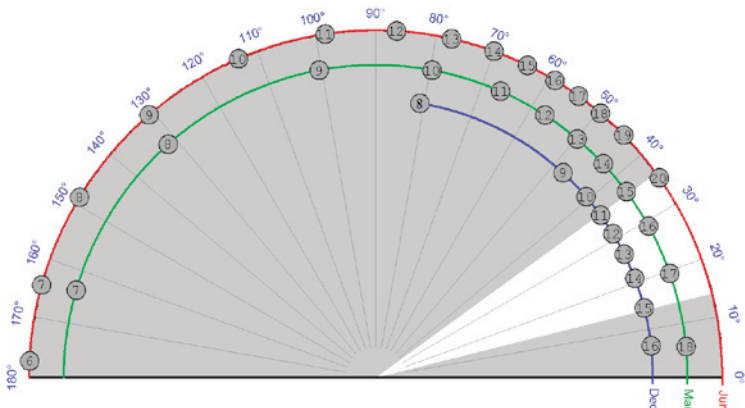
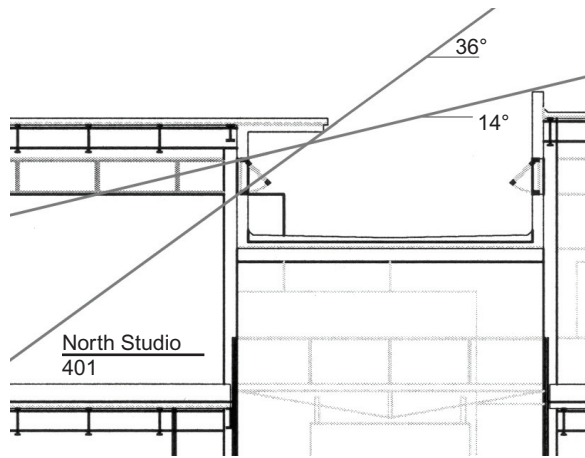
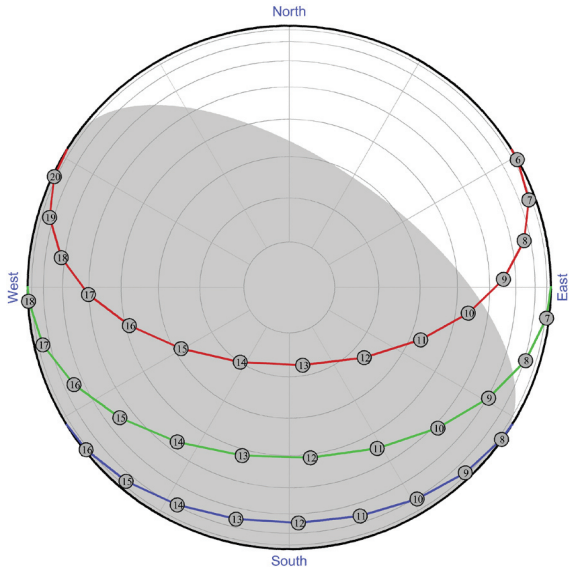
The diagrams marked vertical view, are a polar plot of the path of the sun when looking straight out the window. The gray areas represent the part of the sky that would be shaded by the vertical elements.

The Large columns on the north facade effectively block the sun after 9 am on June 21. During the winter months (October to March) there will be no direct sun penetration into the north studio.



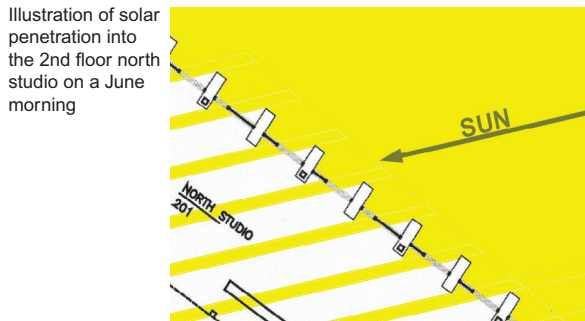
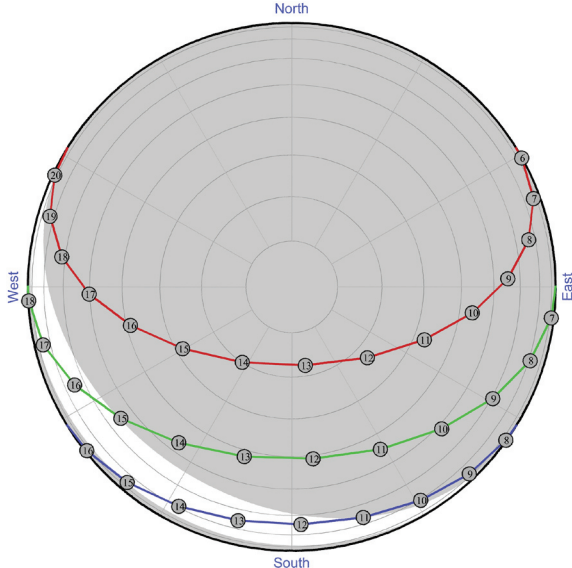
North Studio - North Facade Overhang

In the summer months the sun will shine on the north facade of the building in the morning. The overhang on the north facade will shade the north studio windows after 9:30 in June and after 8:30 in march. In December the sun never shines on the north facade.



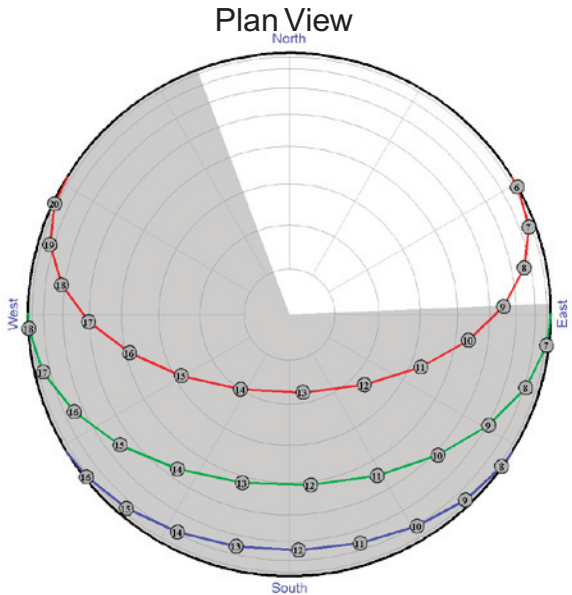
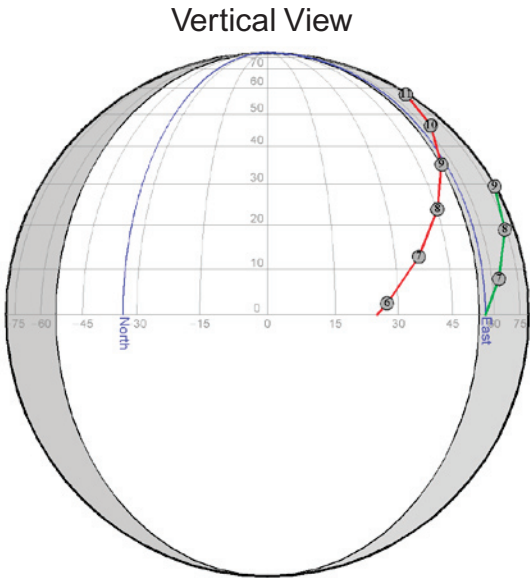
North Studio - Clearstory Overhang

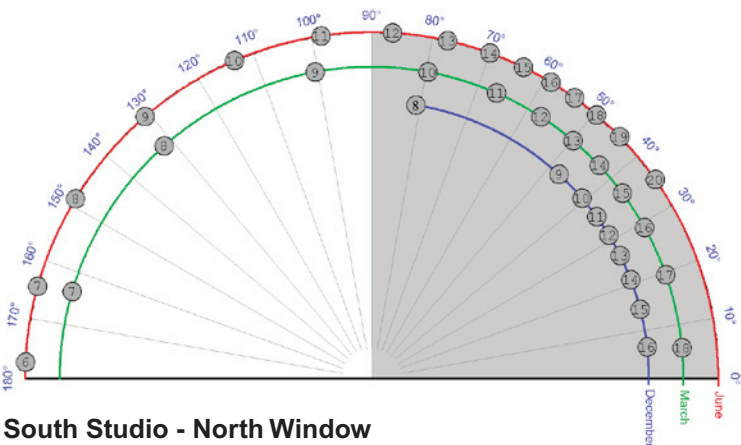
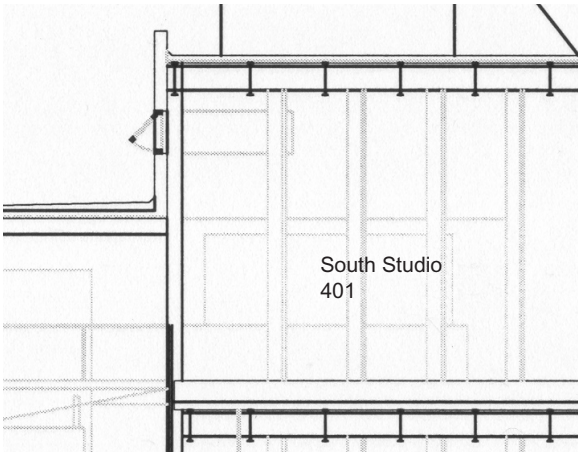
High solar profile angles for the south facing windows of the clearstory are shaded by an overhang, at the same time low solar profile angles are shaded by the parapet on the adjacent clearstory. This results in a window of sun penetration. This penetration is greatest in winter months when the sun is low in the south sky.



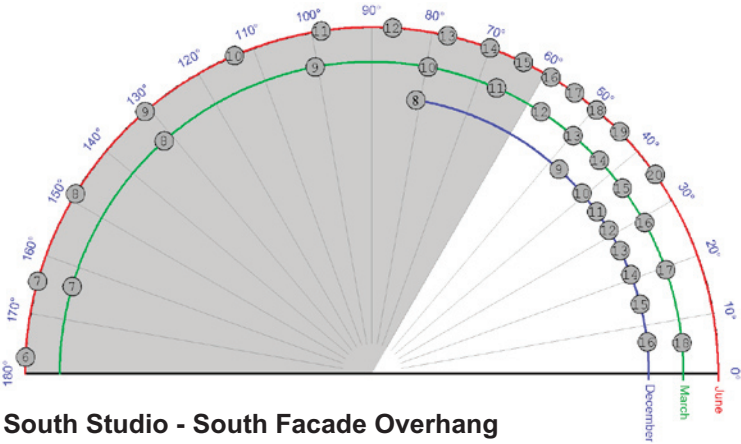
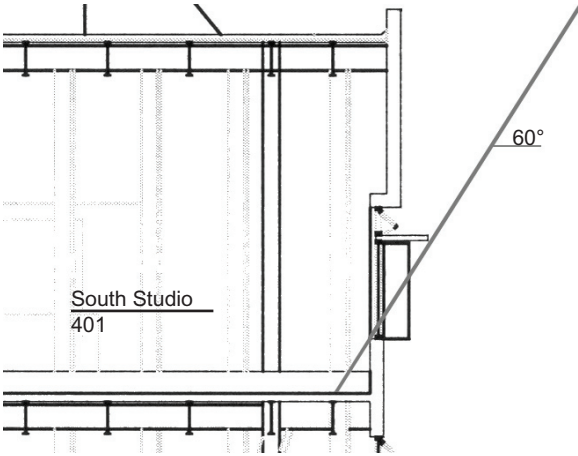
North Studio - Exterior Columns

- June 21 (red) sun blocked after 9:00 am
- March 21 (green) no sun penetration
- December 21 (blue) no sun penetration



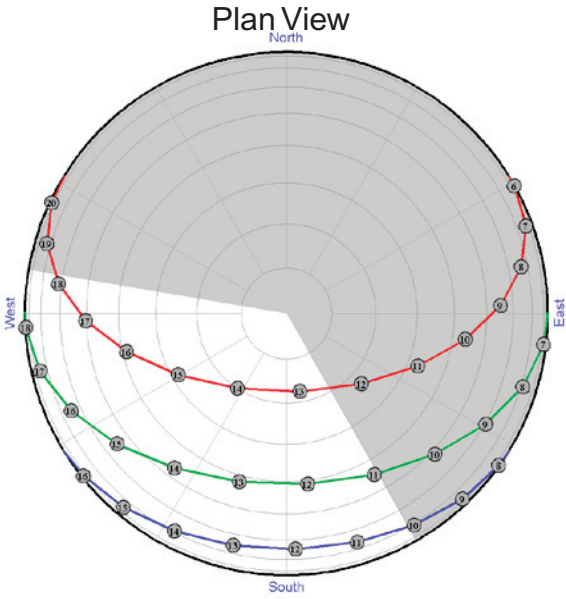
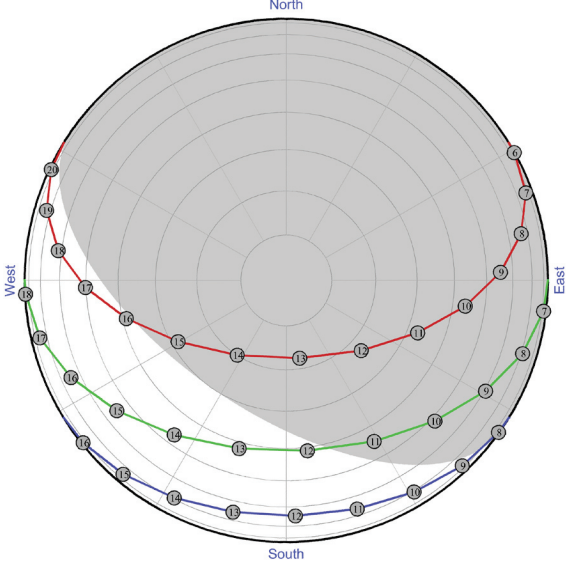
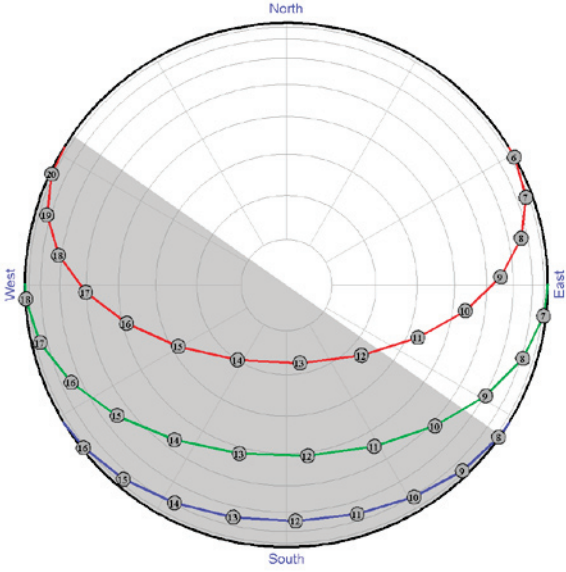
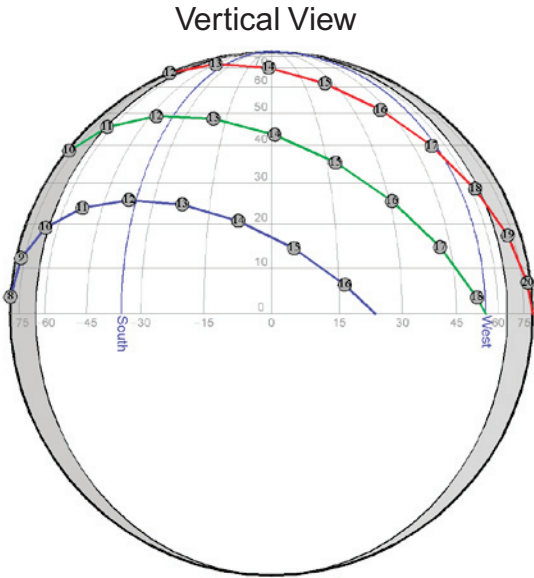


South Studio - North Window
There is no shading for the north window. The sun will penetrate whenever it is in the north sky.



South Studio - South Facade Overhang
The overhang on the south facade blocks the sun at high profile angles. Additional shading on the south facade is likely to be provided by the water tower and nearby trees.

- South Studio - Fins**
- June 21 (red) sun blocked before 12:30 pm and after 6:00 pm
 - March 21 (green) sun blocked before 11:00 am
 - December 21 (blue) sun blocked before 10:00 am



Solar Shading - South Studios

There are no shading elements for the north windows of the 4th floor south studio. Because of the position of this window (20 feet above the floor) direct sun will penetrate deep into the studio.

Shading options include frit, and overhang, but perhaps the most effective would be fins. The azimuthal angle of the sun during times of exposure is such that fins, similar to those proposed for the south windows, could provide the most useful shading.

The overhang above south windows for the south studio will allow sun penetration in the afternoons.

On the windows of the south facade there are fins that which are intended to provide shading for the windows on the fourth floor. The fins act to block morning sun from entering the south studio.

South Studio - Overall Shading

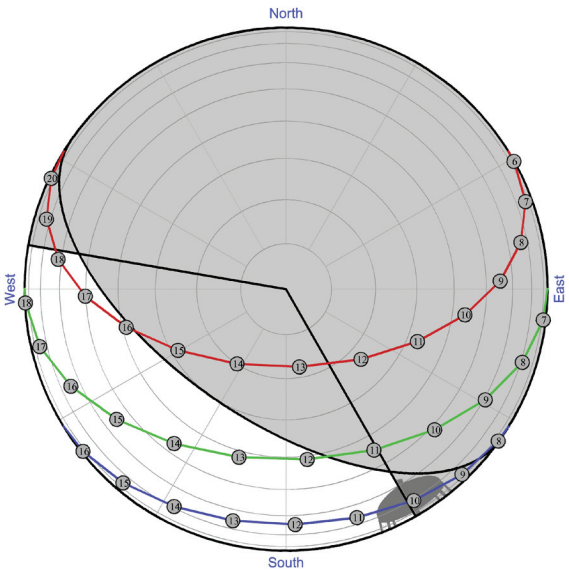
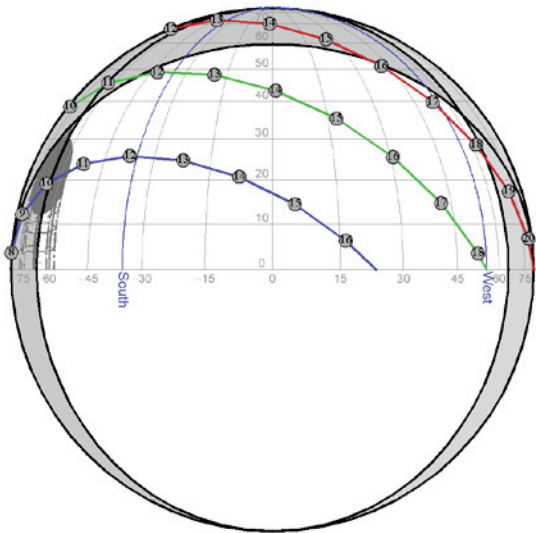
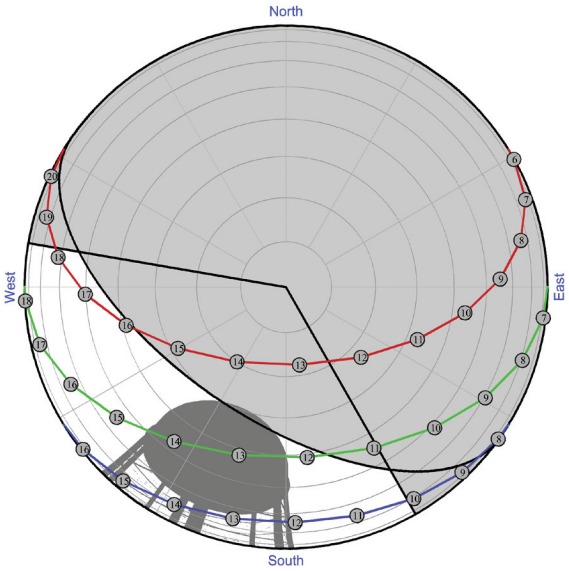
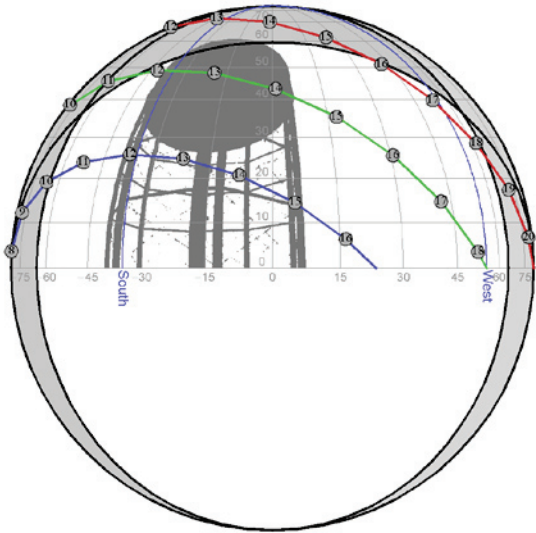
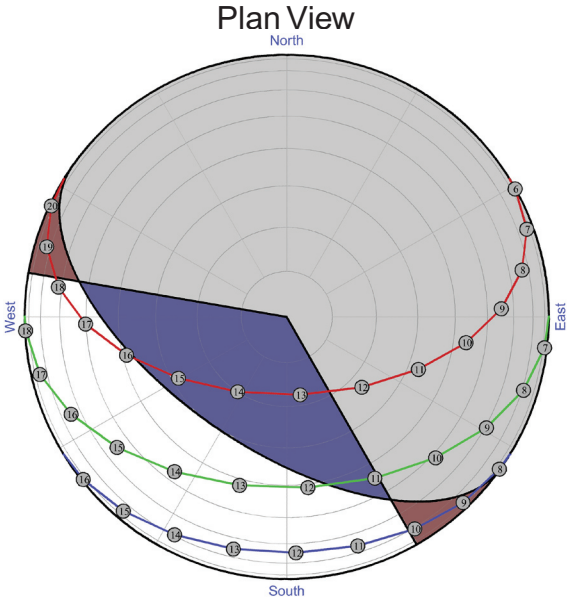
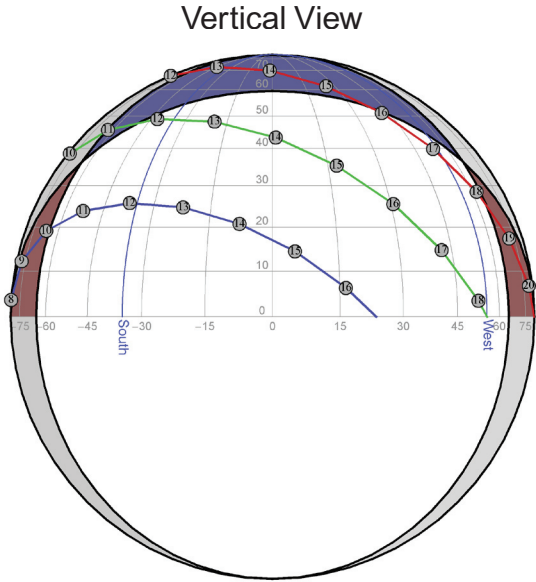
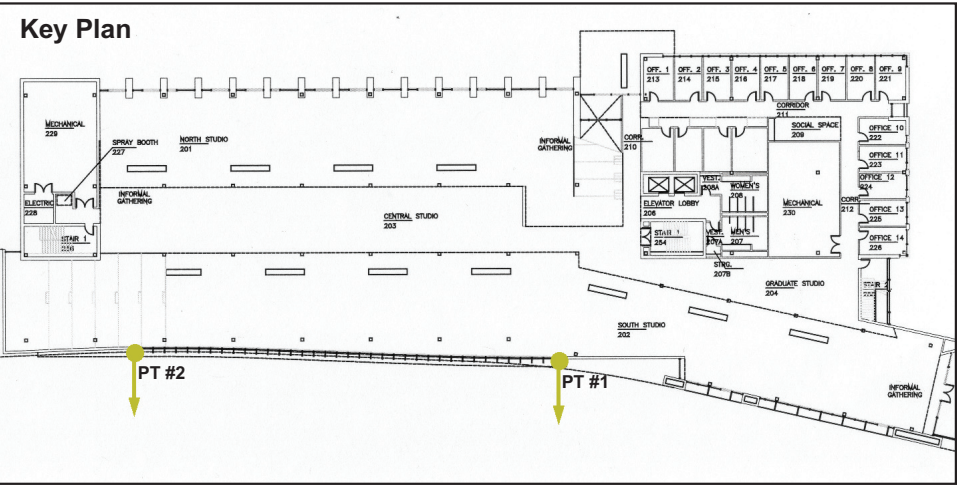
- The overhang blocks afternoon sun in the summer which goes unblocked by the fins.
- The fins block early morning sun in the winter and late evening sun in the summer which goes unblocked by the overhang.

View from point #1

- Water tower provides significant shading year round in the early afternoon.

View from point #2

- Water tower provides some shading during the morning in December.



Shading from Water Tower

The overhang and fins combine to give the shading effect illustrated on the bottom. The gray shaded area is blocked by both the fins and overhang, the blue shaded area is blocked by only the overhang, and the red shaded area is blocked by only the fins. This diagram shows that the fins don't add a lot of shading that is not already provided by the overhang.

The diagrams on this page show the shading elements on the south facade with shading effects from the water tower at two specific points on the facade.

Shading from Trees

Shading will also be provided by trees and other nearby buildings. The photos on this page are of the SALA site and were taken during this summer.

The 50 foot trees opposite the west side of the south facade (Hort woods - image B) will provide significant shading on that part of the facade. We are not concerned with that area. However the trees are thinner towards the east end of that facade, especially in the south-southeast direction. Thus, we are concerned about the east half of south facade, and anticipate sun penetration just before noon.

During the winter, the trees will not have leaves, but Hort woods is dense enough that some shading will still be provided. Also, during the winter the probability of sunshine is rather low. Overall, there will be some direct sun penetration into the south studio through the south windows, but since it is not crucial that direct glare be eliminated completely, and that students can adapt their furniture, and body position to minimize the effects of glare, additional shading for the south windows is not a necessity.

